Translation of Japanese Unexamined Pat. Appl. Publication No. 05-334572

Application No.	04-139507
Filing Date	1 June 1992
Publication No.	05-334572
Publication Date	17 December 1993
Int. Cl.[5]	G08B 15/00; G06F 15/62; G08B 13/196; H04N 5/232; H04N 7/18
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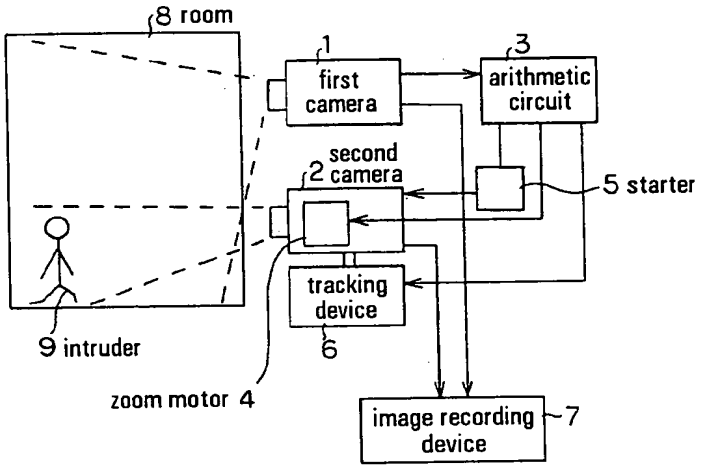
Title

Room Interior Monitoring System

Abstract

OBJECT: To perform appropriate and accurate monitoring of an intruder who has entered a room.

CONSTITUTION: A first camera 1 constantly captures the image of the entire interior of room 8 using a fixed field-of-view. A second camera 2 is started up when the presence of intruder 9 is detected. This second camera captures images in such a manner that characteristics such as the facial features of a person can be ascertained in detail. This is achieved by (i) capturing an enlarged image centred on the intruder and in accordance with the field-of-view [2], and (ii) tracking the movement of the intruder. Commands relating to the detection of intruder 9, the determination of the magnification required for the enlarged image, and the tracking, are all generated by arithmetic circuit 3 on the basis of a video signal from first camera 1. Second camera 2 is started up via starter 5, its magnification is set by built-in zoom motor 4, and it tracks intruder 9 by way of tracking device 6, with all these operations being based on commands from arithmetic circuit 3. Images captured by cameras 1 and 2 are recorded by image recording device 7, and are played back and examined as required.



Claims

1. A room interior monitoring system characterised in that it comprises:

a first image capture device for constantly capturing an image of an entire room interior using a fixed field-of-view;

an arithmetic unit for room entry detection of a moving body that has entered said room interior, and for obtaining the regional and temporal positions [3] of the image of said moving body within the fixed field-of-view of said first image capture device; and

a second image capture device which commences image capture on the basis of said room entry detection performed by the arithmetic unit, zooms in and enlarges at a magnification based on said moving body image region, and tracks said moving body on the basis of said temporal positions of the moving body image.

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* Numbers in square brackets refer to Translator's Notes appended to the translation.

2. The room interior monitoring system according to Claim 1, characterised in that the room entry detection of a moving body is based on image processing comprising subtracting the image of the room interior alone, this having been captured in advance at the outset, from each image captured by the first image capture device as time proceeds.

3. The room interior monitoring system according to Claim 1 or 2, characterised in that the moving body image region within the fixed field-of-view of the first image capture device is based on differences in the values of coordinates at each end of ranges over which a prescribed threshold is equalled or exceeded, these ranges being obtained on the basis of a projection onto X and Y axes of the moving body image in the captured image.

4. The room interior monitoring system according to any of Claims 1 to 3, characterised in that the temporal positions of the moving body image within the fixed field-of-view of the first image capture device are based on barycentric coordinates obtained on the basis of a projection onto X and Y axes of the moving body image in the captured image.

5. The room interior monitoring system according to any of Claims 1 to 4, characterised in that the first image capture device is an infrared passive type device with respect to a moving body, and the second image capture device is a night vision type device.

6. The room interior monitoring system according to any of Claims 1 to 4, characterised in that both the first image capture device and the second image capture device are night vision type devices.

Detailed Description of the Invention

Industrial field of utilisation

(1) This invention relates to room interior monitoring systems which employ the linked operation of two image capture devices to perform appropriate and accurate monitoring of a moving body that has entered a room.*

Prior art

(2) Hitherto, a method that has been adopted in monitoring systems for monitoring the interior of premises such as banks and shops, is to use a fixed field-of-view camera to constantly capture the image of the entire interior of the premises, or to subdivide this interior into a plurality of specific zones and to monitor these using a number of fixed field-of-view cameras.

Problem which the invention will solve

(3) In conventional examples, although the field-of-view assigned to each camera for image capture is slightly different, these fields-of-view are comparatively broad and therefore, although the actions of an intruder can be ascertained, the cameras are inadequate for accurately ascertaining detailed characteristics such as the facial features of the intruder. If the zone assigned to each camera is further subdivided in

* Numbers in round brackets at the beginning of paragraphs correspond to the paragraph numbering in the Japanese patent document.

order to eliminate this defect, the number of cameras increases which is disadvantageous from a cost point of view.

(4) It is the task of the present invention to overcome this problem encountered with the prior art and to provide a room interior monitoring system for appropriately and accurately monitoring a moving body that has entered a room.

Means for solving problem

(5) The room interior monitoring system according to Claim 1 comprises: a first image capture device for constantly capturing an image of an entire room interior using a fixed field-of-view; an arithmetic unit for room entry detection of a moving body that has entered the room interior, and for obtaining the regional and temporal positions of the image of the moving body within the fixed field-of-view of the first image capture device; and a second image capture device which commences image capture on the basis of the aforementioned room entry detection performed by the arithmetic unit, zooms in and enlarges at a magnification based on the moving body image region, and tracks the moving body on the basis of the temporal positions of the moving body image.

(6) The room interior monitoring system according to Claim 2 is the system of Claim 1, wherein the room entry detection of a moving body is based on image processing comprising subtracting the image of the room interior alone, this having been captured in advance at the outset, from each image captured by the first image capture device as time proceeds. The room interior monitoring system according to Claim 3 is the system of Claim 1 or 2, wherein the moving body image region within the fixed field-of-view of the first image capture device is based on differences in the values of coordinates at each end of ranges over which a prescribed threshold is equalled or exceeded, these ranges being obtained on the basis of a projection onto X and Y axes of the moving body image in the captured image.

(7) The room interior monitoring system according to Claim 4 is the system of any of Claims 1 to 3, wherein the temporal positions of the moving body image within the fixed field-of-view of the first image capture device are based on barycentric coordinates obtained on the basis of a projection onto X and Y axes of the moving body image in the captured image. The room interior monitoring system according to Claim 5 is the system of any of Claims 1 to 4, wherein the first image capture device is an infrared passive type device with respect to a moving body, and the second image capture device is a night vision type device.

(8) The room interior monitoring system according to Claim 6 is the system of any of Claims 1 to 4, wherein both the first image capture device and the second image capture device are night vision type devices.

Working of the invention

(9) In the room interior monitoring system according to any of Claims 1 to 6, an image of the entire interior of a room is constantly captured with a fixed field-of-view by the first image capture device. Room entry detection of a moving body that has entered the room is performed by the arithmetic unit on the basis of the video signal from the first image capture device. The regional and temporal positions of the moving body image within the fixed field-of-view of the first image capture device are

likewise obtained by the arithmetic unit on the basis of the video signal from the first image capture device. Image capture by the second image capture device is started on the basis of the room entry detection performed by the arithmetic unit, whereupon the second image capture device zooms in and enlarges at a magnification based on the moving body image region, and tracks the moving body on the basis of the temporal positions of the moving body image, with the moving body image always positioned in approximately the centre of the field-of-view.

(10) In the room interior monitoring system according to Claim 2 in particular, room entry detection of a moving body is performed by the arithmetic unit on the basis of image processing comprising subtracting the image of the room interior alone, this having been captured in advance at the outset, from each image captured by the first image capture device as time proceeds. In the room interior monitoring system according to Claim 3 in particular, the moving body image region within the fixed field-of-view of the first image capture device is obtained by the arithmetic unit on the basis of differences in the values of coordinates at each end of ranges over which a prescribed threshold is equalled or exceeded, these ranges being obtained on the basis of a projection onto X and Y axes of the moving body image in the captured image.

(11) In the room interior monitoring system according to Claim 4 in particular, the temporal positions of the moving body image within the fixed field-of-view of the first image capture device are obtained by the arithmetic unit on the basis of barycentric coordinates obtained on the basis of a projection, onto X and Y axes, of the moving body image in the captured image. In the room interior monitoring system according to Claim 5 in particular, the first image capture device is an infrared passive type device with respect to a moving body, and the second image capture device is a night vision type device. In the room interior monitoring system according to Claim 6, both the first and second image capture devices are night vision type devices and therefore it is possible to monitor inside a room that is always dark or inside a room at night, thereby broadening the scope of utilisation.

Embodiment

(12) An embodiment of the room interior monitoring system of this invention will now be described with reference to the drawings. FIG. 1 is a block diagram showing the constitution of the embodiment. In FIG. 1, first camera 1 constantly captures the image of the entire interior of room 8 using a fixed field-of-view. Second camera 2 is started up when the presence of intruder 9 is detected. This second camera captures images in such a manner that characteristics such as the facial features of a person can be ascertained in detail. This is achieved by (i) capturing an enlarged image centred on intruder 9 and in accordance with the field-of-view, and (ii) tracking the movement of the intruder. Commands relating to the detection of intruder 9, the determination of the magnification required for the enlarged image, and the tracking, are all generated by arithmetic circuit 3 on the basis of a video signal from first camera 1. In other words, second camera 2 is started up via starter 5, is zoomed-in for image enlargement by its built-in zoom motor 4, and tracks intruder 9 by way of tracking device 6, with all these operations being based on commands from arithmetic circuit 3. Images captured by first and second cameras 1 and 2 are recorded by image recording device 7, and are played back and examined as required.

(13) The operation of the embodiment will now be described with reference to FIG. 2, FIG. 3 and FIG. 4. FIG. 2 is the first part of a flowchart showing this operation. FIG. 3 is the second part of this flowchart. FIG. 4 is a schematic drawing showing how the regional and temporal positions of an intruder image are obtained. In FIG. 2 and FIG. 3, each step is represented in a form which expresses an operation of arithmetic circuit 3 (see FIG. 1). Firstly, at step S1 a counter ***i*** is initialised, this counter indicating the passage of time and being applied to images from first camera C1. At step S2, fixed field-of-view image ***Gi*** of the entire room interior as obtained by camera C1 at time ***Ti*** is fetched. At step S3, image processing for extracting intruder image ***Gmi*** is performed. ***Gmi*** is equivalent to ***Gi–G0***, where ***G0*** is the initial image of just the room interior. In other words, image processing is performed to subtract ***G0*** from the image ***Gi*** of the entire room interior at time ***Ti***, thereby extracting intruder image ***Gmi***. At step S4, intruder image ***Gmi*** is binarized, whereby image ***Gni*** is obtained.

(14) At next step S5, it is decided whether there is an image ***Gni*** (more precisely, whether there is an image at or beyond a prescribed region). If there is no image ***Gni***, processing shifts to step S12, while if there is such an image, processing shifts to step S6 and it is decided whether or not counter ***i*** is equal to 1. The method for obtaining the region of this image ***Gni*** will be described in detail hereinafter when step S15 is considered. In the initial processing cycle, the result of the decision at step S6 is YES and therefore processing shifts to step S7 and camera C2 is started up. Then, at step S8, an anomaly alarm is turned ON (i.e., an alarm is raised). In the second and subsequent processing cycles, the result of the decision at step S6 is NO and therefore processing shifts to step S15. The procedure so far relates to intruder detection.

(15) In FIG. 3, at step S9, the region coordinates of image ***Gni*** are obtained [4]. In other words, the size of the image is obtained. (The method employed will be described in detail in the discussion of step S15.) After this, at step S10, the magnification to be employed by camera C2 is determined on the basis of the region of image ***Gni*** [5], and a zoom operation command is issued. At next step S11, after ***i*** has been incremented, processing returns to step S2. Looking again at step S5, if it is decided that there is no image ***Gni***, processing shifts to step S12, where ***i*** = 0 is set. At step S13, the anomaly alarm is turned OFF (i.e., an "all-clear" is given) and at step S14 the operation of camera C2 is stopped.

(16) Looking again at step S6, if the decision result is NO, i.e., in the second or a subsequent processing cycle, processing shifts to step S15, where the following processing is performed. Namely, the region coordinates and barycentric positions of image ***Gni*** and image ***Gni–1*** (the image at the prior point in time) are obtained in the manner to be described hereinafter. As a result, firstly, at step S16, the magnification for camera C2 is determined on the basis of the ratio of the size of the field-of-view image from camera C1 and the region of image ***Gni***, and a zooming operation is commanded. Secondly, at step S17, on the basis of the displacement of the centre of gravity between images ***Gni*** and ***Gni–1***, a tracking command for tracking the intruder is issued to tracking device 6 on which camera C2 is mounted (see FIG. 1). After steps S14 and S17, ***i*** is incremented at step S11, after which processing returns to step S2 and similar processing is repeated.

(17) Looking again at step S15, the method for obtaining the region and barycentric position of image ***Gni*** will be explained with reference to the schematic drawing presented in FIG. 4, which shows how the regional and temporal positions of the intruder image are obtained. FIG. 4 shows the image capture screen of first camera C1 at a certain point in time. In FIG. 4, *G* references the intruder image, *A* references a rectangular region indicative of the size of image *G*, and *P* references the centre of gravity of intruder image *G*. Region *A* is obtained by projecting image *G* onto X and Y axes established for the captured image [6], and then obtaining coordinates X2, X1, Y2 and Y1 at each end of the ranges over which a threshold (indicated in FIG. 4 by the broken lines drawn parallel to the axes) is equalled or exceeded. The sides of rectangle *A* are given by (X2–X1) and (Y2–Y1), these being the respective difference values. The position of centre of gravity *P* is obtained as coordinates Xp and Yp, these coordinates being found by projecting image *G* onto the X and Y axes. Hence the movement of intruder image *G* is ascertained on the basis of coordinates Xpi and Ypi of centre of gravity *P* at each point of time ***Ti***, which means that tracking by camera C2 is possible by way of the tracking device.

(18) Note that in FIG. 1, by using an infrared passive type camera sensitive to the infrared rays emitted from intruder 9 as first camera 1, and a night vision type camera as second camera 2, or by using night vision type cameras for both first camera 1 and second camera 2, it will be possible to monitor the interior of a room which is always dark or the interior of a room at night without intruder 9 realising this, thereby extending the range of utilisation of the invention.

Effect of the invention

(19) In the room interior monitoring system according to any of Claims 1 to 6, an image of the entire interior of a room is constantly captured with a fixed field-of-view by a first image capture device. Room entry detection of a moving body that has entered the room is performed by an arithmetic unit on the basis of the video signal from the first image capture device. The regional and temporal positions of the moving body image within the fixed field-of-view of the first image capture device are likewise obtained by the arithmetic unit on the basis of the video signal from the first image capture device. Image capture by a second image capture device is started on the basis of the room entry detection performed by the arithmetic unit, whereupon the second image capture device zooms in and enlarges at a magnification based on the moving body image region, and tracks the moving body on the basis of the temporal positions of the moving body image, with the moving body image always positioned in approximately the centre of the field-of-view. Consequently, all actions of an intruder within the room are constantly and inclusively captured by the first image capture device and, from the point in time when the intruder has entered the room, an enlarged detailed image of the intruder is tracked and captured by the second image capture device in such manner that the intruder image is always positioned in the central portion of the field-of-view. It is therefore possible to obtain an accurate grasp of both the overall situation and its more localised aspects, which in turn means that it is easy to both locate and determine the nature of an intruder.

(20) In particular, in the room interior monitoring system according to Claim 5 the first image capture device is an infrared passive type device in respect of moving bodies and the second image capture device is a night vision type device, while in the

room interior monitoring system according to Claim 6, both the first and second image capture devices are night vision type devices. It is therefore possible to monitor the interior of a room which is always dark or the interior of a room at night, thereby extending the range of utilisation of the invention.

Brief Description of the Drawings

FIG. 1 is a block diagram showing the constitution of an embodiment of the present invention.

FIG. 2 is the first part of a flowchart showing the operation of the embodiment.

FIG. 3 is the second part of the flowchart showing the operation of the embodiment.

FIG. 4 is a schematic drawing showing how the regional and temporal positions of an intruder image are obtained.

Key to referencing numerals

1.....first camera
2.....second camera
3.....arithmetic circuit
4.....zoom motor
5.....starter
6.....tracking device
7.....image recording device
8.....room
9.....intruder

FIG. 1

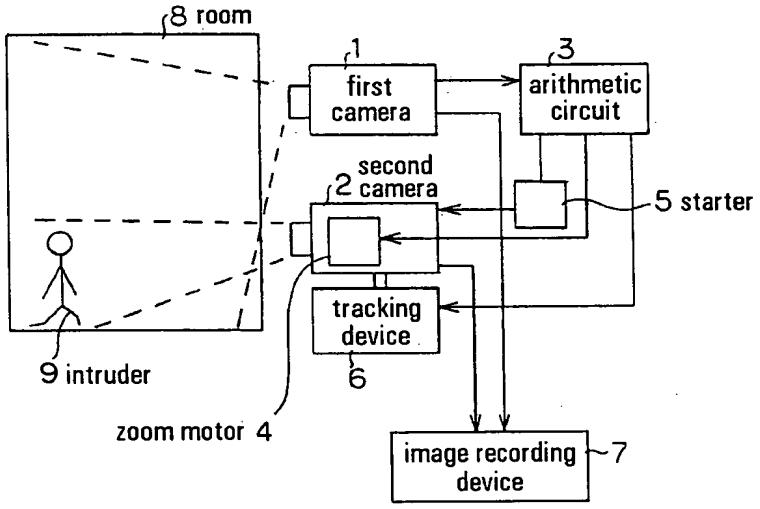


FIG. 2

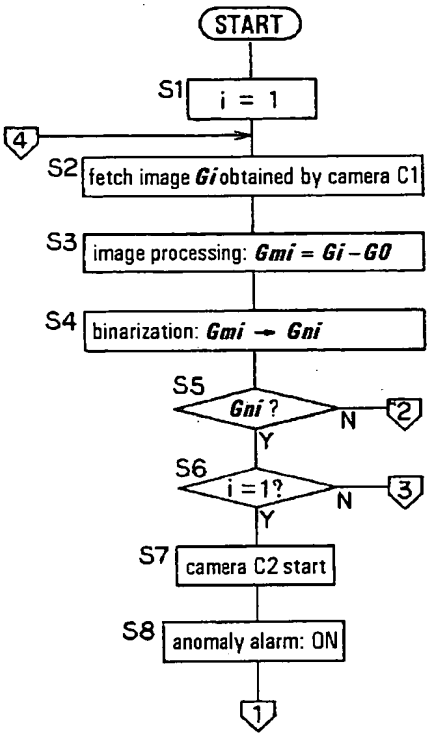

START
S1
i = 1
4
S2
fetch image Gi obtained by camera C1
S3
image processing: Gmi = Gi − G0
S4
binarization: Gmi → Gni
S5
Gni ?
N
2
Y
S6
i = 1?
N
3
Y
S7
camera C2 start
S8
anomaly alarm: ON
1

FIG. 3

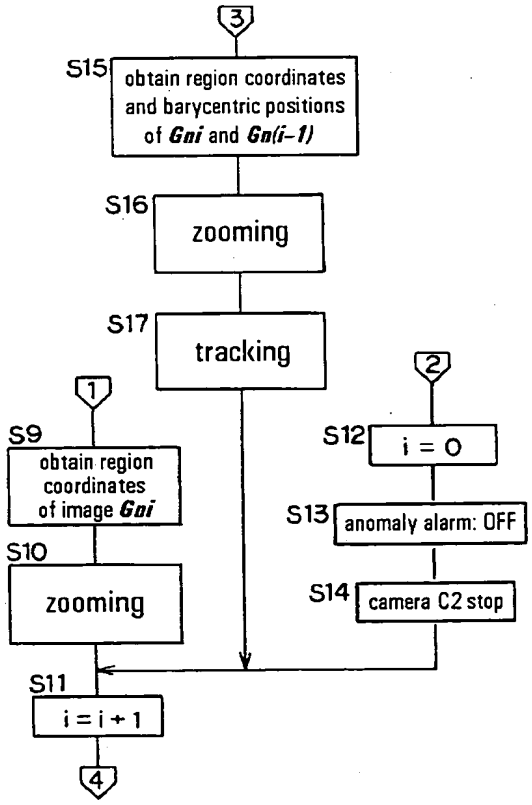
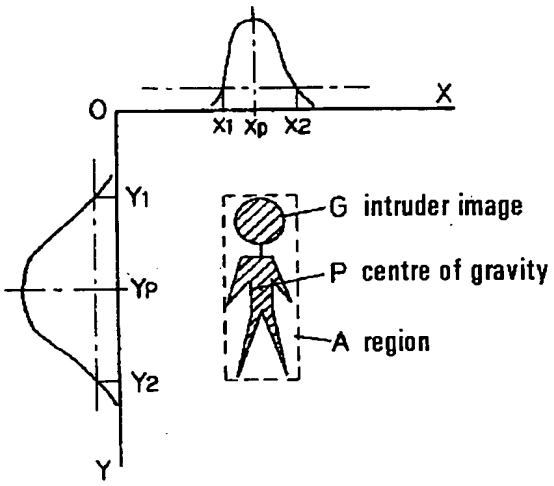

3
S15
obtain region coordinates and barycentric positions of Gni and Gn(i−1)
S16
zooming
S17
tracking
1
S9
obtain region coordinates of image Gni
S10
zooming
2
S12
i = 0
S13
anomaly alarm: OFF
S14
camera C2 stop
S11
i = i + 1
4

FIG. 4



TRANSLATOR'S NOTES

1. From December 1997, the company name "Fuji Facom Corporation" was officially changed to "FFC Limited".
2. Sic. It is not clear to me whether "capturing an enlarged image ... in accordance with the field-of-view" means anything more than that the degree of enlargement and the field-of-view are interdependent.
3. Sic. This phrase, "obtaining the regional and temporal positions [of an image]" occurs repeatedly throughout the Japanese document. The writer appears to be using this wording to refer to processing whereby a time-series of positions of the image of a moving body (i.e., an intruder) in relation to the overall image of a room interior is obtained. The details of this processing are clarified by FIG. 4 and its discussion.
4. Sic. By "region coordinates of image ***Gni***", the writer appears to mean the coordinates defining the region or area, within the overall room interior image, that is occupied by the intruder image.
5. Sic. By "region", the writer means the image size.
6. This reference to "the captured image" is presumably a reference to the whole-room image captured by the fixed field-of-view camera, this image providing a reference 2-dimensional space in relation to which the size and position of the intruder image obtained by the second camera is ascertained.